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(54) A device for reducing atmospheric pollution by exhaust gases from internal combustion engines.

(57) The device (1) comprises a hollow casing (2) provided with an inlet (3) for exhaust gases to be purified and an outlet (4) for the purified exhaust gases, and purifier means (5) interposed between the said inlet (3) and outlet (4) and substantially constituted by mineral fibres (6) activated by a noble metal catalyst deposited on them.

The device (1) further includes support means (15) for the mineral fibres (6) essentially constituted by a woven filiform material engaged on the fibres (6) in such a way as to define, between the said inlet (3) and outlet (4), a substantial alternation of layers of filiform material (15) and mineral fibres (6).

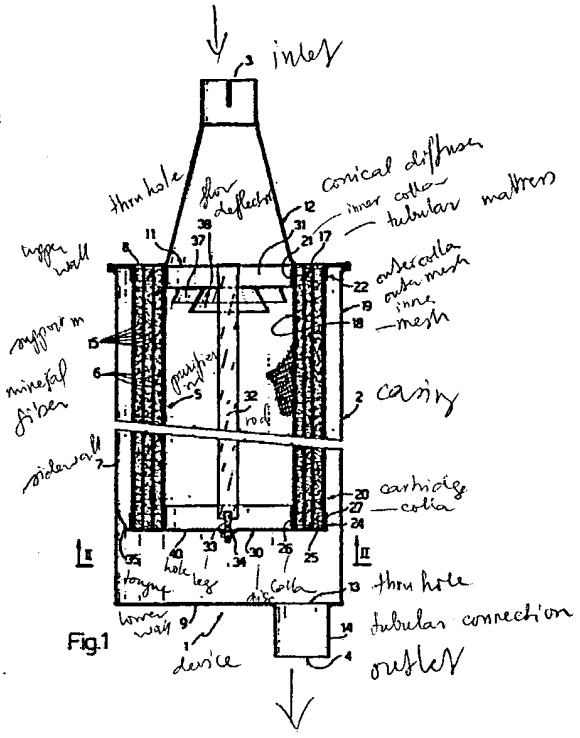

Fig.1

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A DEVICE FOR REDUCING ATMOSPHERIC POLLUTION BY EXHAUST GASES FROM INTERNAL COMBUSTION ENGINES

The present invention relates to a device for reducing atmospheric pollution by exhaust gases of internal combustion engines. More particularly, the present invention relates to a device for reducing atmospheric pollution by the exhaust gas as from diesel cycle engines both those installed on vehicles and those installed in static installations (for example generating plants).

As is known, internal combustion engine exhaust gases, particularly from diesel cycle engines utilising diesel oil as a fuel, contain numerous noxious substances such as, for example, unburnt hydrocarbons, particles, oxides of nitrogen and carbon etc.

There are many known systems and devices designed for reducing atmospheric pollution due to internal combustion engine exhaust gases. In general these are of the type comprising a hollow casing provided with an inlet for the exhaust gas to be purified and an outlet for the purified exhaust gas, and purifying means interposed between the said inlet and outlet.

By way of example it is known to use ceramic trap devices which retain the particles present in the exhaust gas and then burn them by means of suitable heating flames supplied by an appropriate burner. Such devices have not found wide application because of the excessively high cost.

The object of the present invention is that of providing a device for reducing atmospheric pollution by exhaust gases from internal combustion engines, able to effect a purification such as drastically to reduce the toxicity of such exhaust gases whilst being of a restricted production cost in comparison with known devices of the above specified type.

The said object is achieved by the present invention in that it relates to a device for reducing atmospheric pollution by internal combustion engine exhaust gases, of the type comprising a hollow casing provided with an inlet for the exhaust gas to be purified and an outlet for the purified exhaust gases, and purifier means interposed between the said inlet and outlet, characterised by the fact that the said purifier means essentially comprise mineral fibres activated by means of a catalyst of noble metal.

For a better understanding of the present invention a preferred embodiment is described hereinafter purely by way of non-limitative example and with reference to the attached drawings, in which:

Figure 1 is a sectional side view of a device formed according to the present invention;

Figure 2 is a section, on an enlarged scale, taken on the line II-II of Figure 1;

Figure 3 is a view on an enlarged scale of a detail of Figure 1;

Figure 4 illustrates a detail of a production stage of a detail of the device in question; and

Figure 5 illustrates on an enlarged scale the structure of a detail of Figure 4.

With particular reference to Figure 1, a device for reducing atmospheric pollution by exhaust gases of internal combustion engines formed according to the principles of the present invention is generally indicated with the reference numeral 1.

The device 1 is of the type comprising a hollow casing 2 provided with an inlet 3 for the exhaust gases to be purified and an outlet 4 for the purified exhaust gases, and purifier means 5 interposed between the said inlet 5 and outlet 4.

In more detail, the casing 2 has a cylindrical structure with tubular side walls 7, an upper wall 8 and a lower wall 9. The upper wall 8 has an axial through-hole 11 and supports a conical diffuser 12 the purpose of which is to allow a progressive expansion of the exhaust gas to be purified coming from the inlet 3. The lower wall 9 has an offset through-hole 13 in which is fixed a tubular connector 14.

According to a first aspect of the present invention the purifier means 5 are essentially constituted by mineral fibres 6 rendered active by means of a noble metal catalyst deposited thereon. These fibres 6 can be amorphous, "disordered", practically free from mechanical strength, or else aligned, "ordered", in such a way as to present a mechanical strength at least three times that of the mechanical strength of the amorphous fibres. Moreover, these are preferably constituted by quartz and/or silica fibres, whilst the noble metal catalyst is advantageously a platinum catalyst.

According to a further aspect of the present invention the device 1 includes support means 15 for the mineral fibres 6, essentially constituted by a stocking of woven filiform material contacting these fibres 6 in such a way as to define, between the inlet 3 and the outlet 4, alternate layers of filiform material 15 and mineral fibres 6.

The stocking 15 of woven filiform material, a portion of which is illustrated in detail in Figure 5, is constituted by a plurality of free and elastically deformable meshes conveniently made by mechanical knitting of a stainless steel wire particularly adapted to resist high temperatures such as those of the exhaust gases of an internal combus-

tion engine.

It is observed that the mineral fibres 6 and the stocking 15 of woven filiform material are wound in a coil (as illustrated in Figure 4) in such a way as to define a tubular mattress 17 which is interposed between two tubular metal meshes, respectively an inner mesh 18 and an outer mesh 19. Preferably, these meshes 18, 19 are obtained as expanded metal meshes of stainless steel sheet of a type adapted to resist high temperature as specified above.

The mineral fibres 6, the stocking 15 and the rigid meshes 18, 19 together define a cartridge 20 which is installed in axial position within the casing 2 and is dimensioned in such a way that the diameter of the inner mesh 18 is substantially coincident with the diameter of the through-hole 11 in the upper wall 8 of the casing 2.

The upper portion of the cartridge 20 is positioned, in use, between inner and outer centring collars 21, 22 extending from the inner side of the upper wall 8 of the casing 2 through the through-hole 11 mentioned above.

The lower portion of the cartridge 20 is housed within an annular bowl 24 substantially constituted by a flat ring 25 and two collars 26, 27 extending perpendicularly from this latter and entirely identical to the collars 21, 22 described above.

The device 1 has a further innovative characteristic according to which the dimensions of the cartridge 20 in a longitudinal and transverse sense are less than the respective internal longitudinal and transverse dimensions of the casing 2, for the purpose of allowing, in use, an expansion thereof within the casing itself without creating mechanical stresses between these two components. In particular, the cartridge 20 is retained in the working position by means of a disc 30 resting on the lower surface of the annular bowl 24 and mechanically connected to a crosspiece 31 supported by the collar 21 by means of an axial tie rod 32 a threaded leg 33 of which retains the disc 30 by means of a nut 34. The material constituting the tie rod 32 is of the same type as that constituting the rigid meshes 18, 19 of the cartridge 20, in such a way as to present a substantially identical thermal expansion to that of the meshes 18, 19 themselves.

The disc 30 is provided with a set of three radial tongues 35 angularly equidistant from one another and extending towards the inner surface of the lateral wall 7 of the casing 2 without, however, touching this latter (Figures 2 and 3). The tongues 35 are bent with respect to the plane of the disc 30 in such a way as to form with this latter an angle of substantially 45° and present a circular outline such that these do not dig in to the wall 7 during longitudinal excursions of the cartridge 20 by the effect of the increase in the working temperature.

For the purpose of distributing exhaust gases uniformly over the entire inner surfaces of the cartridge 20 the device 1 is provided with a pair of flow deflectors 37, 38 substantially constituted by tubular elements of conical profile of different diameters fixed coaxially to the crosspiece 31.

According to a further characteristic of the present invention the disc 30 is provided with a through-hole 40 of suitable dimensions, which puts the inlet 3 in direct communication with the outlet 4 of the casing 2.

The device 1 operates in general in a manner similar to known devices of this type in the sense that the exhaust gases gain access to the interior of the casing 2 through the inlet 3 and subsequently flow to the outlet 4 after having traversed the cartridge 2 and having been purified by means of the purifier 5 contained in it.

From the conceptual point of view the adoption of mineral fibres 6 clad with a catalyst allows unexpected and surprising results to be obtained from the point of view of the destruction of polluting particles contained in the exhaust gases.

The fibres 6 used in the production of the device 1, which in an experiment which was performed had an active surface estimated at about 24 m^2 were found sufficient to oxidise the residual unburnt carbon particles in an amount approximately equal to one point on the Bosch smoke scale.

By examining in detail the structure of the device 1 numerous characteristics are noted which render this device signficantly effective.

In particular, the use of the stocking 15 of woven wire-like material certainly performs two important functions:

a principle function consisting in supporting the mineral fibres 6 correctly for the purpose of maintaining them always distributed in a uniform manner within the interior of the cartridge 20 and therefore making the purifying effect homogeneous in time;

a secondary, but equally important function, consisting in creating, between the inlet 3 and the outlet 4, an alternating set of layers of mineral fibres and wire material, this latter causing a certain separation between adjacent layers of mineral fibres and therefore a good distribution of the flow of gas between the mineral fibres themselves, and, ultimately, an optimum purifying effect.

The system for fixing the cartridge 20 to the casing 2 by means of the tie rod 32 (having a coefficient of thermal expansion similar to that of the rigid meshes 18, 19) allows, simultaneously, the fixing of the cartridge 20 to the casing 2 and the free expansion of the meshes 18, 19 without causing rupture of these meshes by exceeding the yield points of the respective metal materials.

The presence of the hole 40 in the disc 30 has substantially no effect in normal operating conditions of the device 1, that is to say in the case in which the combustion residues are consumed by part of the purifier means 5 in such a way as to cause no accumulation of these between the fibres 6. In the case in which such eventuality occurs, the momentary blockage of the cartridge 20 and the constant inflow of gases to the interior thereof cause an excess pressure which does not exceed a predetermined safety level since the discharge gas can momentarily flow out through the hole 40 allowing the purifier means 5 to digest the overload of combustion residues.

Finally, the combined action of the diffuser 12 and the flow deflectors 37, 38 permits possible damage due to the rapid expansion of the exhaust gas jet flowing into the interior of the cartridge 20 to be reduced to the minimum.

From a study of the characteristics of the device formed according to the present invention the advantages which it allows to be obtained are therefore evident.

The high efficiency of the purifier means 5, conveniently supported by the stocking 15 of resiliently deformable woven metal wire permits a drastic reduction in the more noxious and repeated emissions such as the particles and oxides of nitrogen, and the almost total elimination of the oxides of carbon and unburnt hydrocarbons, containing the back pressure within more than acceptable limits.

Beyond the overall improvement in the purifying efficiency and functionality, it is observed that the device 1 can be made at an overall cost which is significantly less than the cost of ceramic devices currently utilised and described above.

As far as the possible utilisation of the device formed according to the present invention is concerned, it is noted that, as a rule, it can be utilised advantageously to treat exhaust gases from any type of internal combustion engine, whether it be of the Diesel cycle or Otto cycle type, installed on vehicles or in fixed installations (for example generators) as well as to treat the exhaust gases of heating boilers adapted for industrial and civil installations.

Finally, it is clear that the device 1 described above can have modifications and variations introduced thereto without however departing from the present invention.

For example, it is evident that wide modifications can be introduced to the structure of the cartridge 2 whilst retaining the principle of interposing between the inlet 3 and the outlet 4 of the casing 2 alternate layers of mineral fibres and stockings of woven wire-like material. In the case in which these two elements are wound in a spiral (as illustrated in Figure 4) the stocking 15 could be disposed on a single face of the layer 6 of fibres in that during the course of the winding this alternation of layers described above would in any case be obtained.

The support for the cartridge 20 could be achieved by means of several tie rods either positioned within or outside the cartridge itself, the concept of utilising a material with a coefficient of thermal expansion as close as possible to that of the rigid meshes 18, 19 remaining the same. It is also evident that other ways of support could be thought up, for example utilising resilient means able to maintain the cartridge in the correct working position whilst allowing termal expansion in longitudinal and transverse directions within the associated case.

The number of flow deflectors could be greater or less than two, and the associated structure could be different from the conical structure described above.

Claims

1. A device for reducing atmospheric pollution by the exhaust gases of internal combustion engines of the type comprising a hollow casing provided with an inlet for exhaust gases to be purified and an outlet for the purified exhaust gases, and purifier means interposed between the said inlet and outlet, characterised by the fac that the said purifier means (5) essentially comprise mineral fibres (6) activated by means of a noble metal catalyst.

2. A device according to Claim 1, characterised by the fact that the said mineral fibres (6) are "disordered" amorphous fibres.

3. A device according to Claim 1, characterised by the fact that the said mineral fibres (6) are aligned "ordered" fibres.

4. A device according to any preceding Claim, characterised by the fact that the said mineral fibres (6) are fibres of quartz and/or silica.

5. A device according to any preceding Claim, characterised by the fact that the said noble metal catalyst is a catalyst of platinum.

6. A device according to any preceding Claim, characterised by the fact that it includes support means (15) for the said mineral fibres (6) essentially constituted by woven filiform material in contact with the said fibres (6) in such a way as to define, between the said inlet (3) and outlet (4), a substantial alternation of layers of filiform material (15) and mineral fibres (6).

7. A device according to Claim 6, characterised by the fact that the said support means (15) are essentially constituted by a stocking of woven fili-

form material having a plurality of resiliently deformable free loops conveniently obtained by mechanically knitting a stainless steel wire particularly adapted to resist high temperatures.

8. A device according to Claim 7, characterised by the fact that the said mineral fibres (6) and the said stocking (15) of filiform material are wound into a spiral in such a way as to define a tubular mattress (17) interposed between an inner tubular metal mesh (18) and an outer tubular metal mesh (19).

9. A device according to Claim 8, characterised by the fact that the said tubular meshes (18, 19) are made of stainless steel of the type adapted to resist high temperature.

10. A device according to Claim 8 or Claim 9, characterised by the fact that the said mineral fibres (6), the said stocking (15) and the said rigid meshes (18, 19) together define a cartridge (20) installed in an axial position within the interior of the said casing (2) and dimensioned in such a way that the diameter of the said inner mesh (18) is substantially coincident with the diameter of a through-hole (11) in an upper wall (8) of the said casing (2).

11. A device according to Claim 10, characterised by the fact that it includes centring means (21, 22) for an upper portion of the said cartridge (20) with respect to the said upper wall (8) of the said casing (2).

12. A device according to Claim 11, characterised by the fact that the said centring means (21, 22) are substantially constituted by an inner collar (21) and an outer collar (22) extending from the inner side of the said upper wall (8) of the said casing (2) around the said through-hole (11).

13. A device according to any of Claims from 10 to 12, characterised by the fact that it includes means (24) for housing a lower portion of the said cartridge (20).

14. A device according to Claim 13, characterised by the fact that the said housing means (24) are essentially constituted by an annular bowl (24) having a flat ring (25) and two collars (26, 27) extending perpendicularly from this latter.

15. A device according to any of Claims from 10 to 14, characterised by the fact that the said cartridge (20) has longitudinal and transverse dimensions less than the respective inner longitudinal and transverse dimensions of the said casing (2).

16. A device according to Claim 15, characterised by the fact that the said cartridge (20) is maintained in its working position by means of supports (30, 31, 32) adapted to allow thermal expansion of the said cartridge (20) at least in a longitudinal direction.

17. A device according to Claim 16, characterised by the fact that the said support means (30, 31, 32) comprise a disc (30) substantially resting on the lower surface of the said cartridge (20) and mechanically connected to the said upper wall (8) of the said casing (2) by means of an axial tie rod (32).

18. A device according to Claim 17, characterised by the fact that the said tie rod (32) is made of material of the same type as that constituting the said rigid meshes (18, 19) of the said cartridge (20).

19. A device according to Claim 17 or Claim 18, characterised by the fact that the said disc (30) is provided with spacer and guide means (35) for excursions of the said cartridge (20), facing towards a side wall (7) of the said casing (2).

20. A device according to Claim 19, characterised by the fact that the said spacer and guide means (35) are essentially constituted by a plurality of radial tongues (35) extending from the said disc (30) towards the inner surface of the said side wall (7) of the said casing (2) without however engaging the wall (7) itself.

21. A device according to Claim 2, characterised by the fact that the said tongues (35) are disposed equidistantly and are bent with respect to a plane defined by the said disc (30).

22. A device according to any preceding Claim, characterised by the fact that it includes means (40) for direct communication between the said inlet (3) and outlet (4) of the said casing (2).

23. A device according to Claim 22 when dependent on any of Claims from 17 to 21, characterised by the fact that the said direct communication means (40) are essentially constituted by a through-hole (40) formed in the said disc (30).

24. A device according to Claim 10 or any of Claims from 11 to 23 when dependent on Claim 10, characterised by the fact that it includes flow deflector means (37, 38) for the said exhaust gases, interposed between the said inlet (3) and the said cartridge (20).

25. A device according to any preceding Claim, characterised by the fact that it includes a diffuser (!2) disposed immediately downstream of the said inlet (3) of the said casing (2).

26. A device according to any preceding Claim, characterised by the fact that the said inlet (3) is connected to the exhaust of a diesel engine, and by the fact that the said outlet (4) is connected to the atmosphere.

27. A device according to any of Claims from 1 to 25, characterised by the fact that the said inlet (3) is connected to the exhaust of a diesel engine and the said outlet (4) is connected to a heat recovery unit.

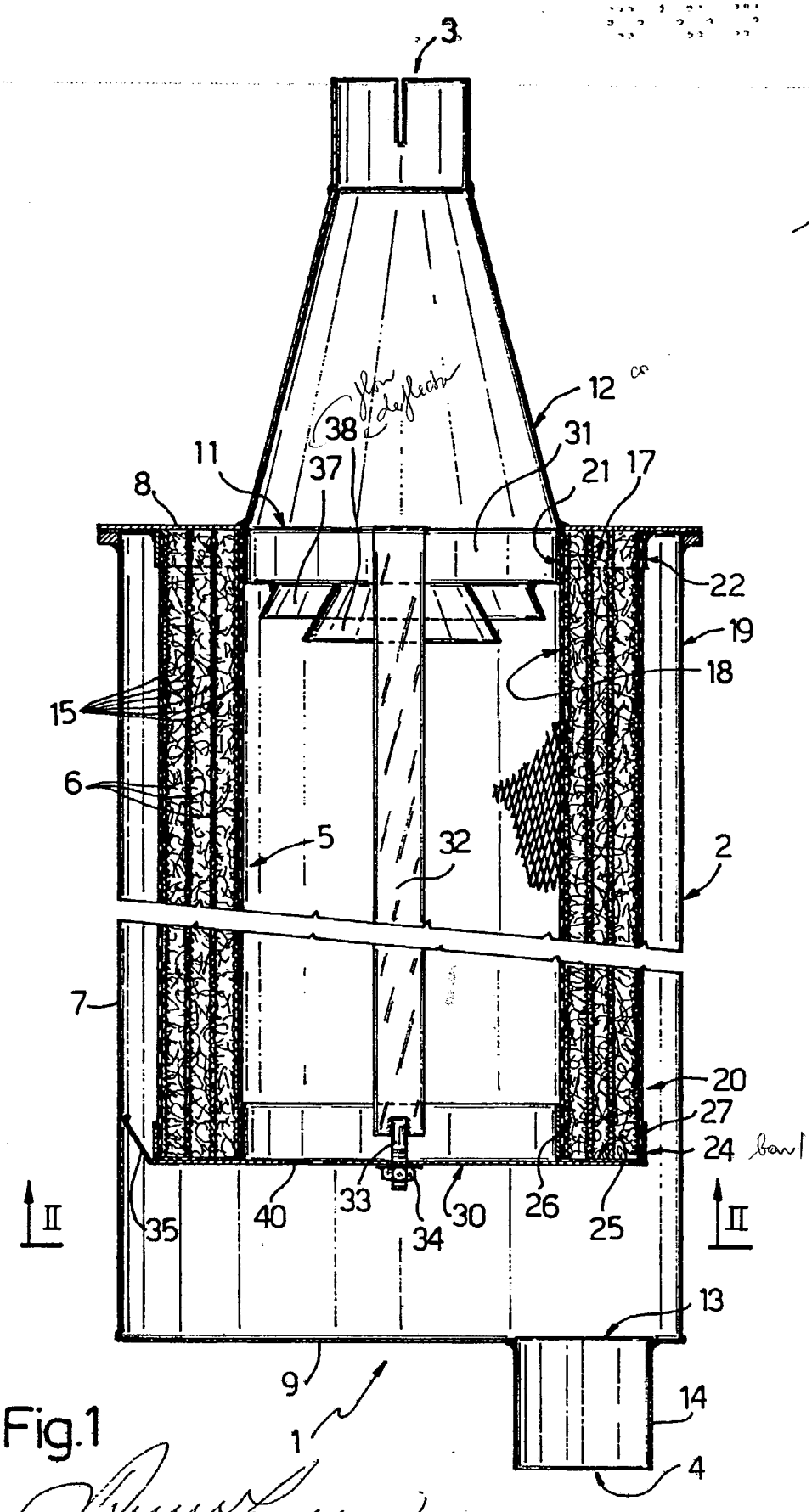

Fig.1

(Dr. Ing. Paolo JORIO)

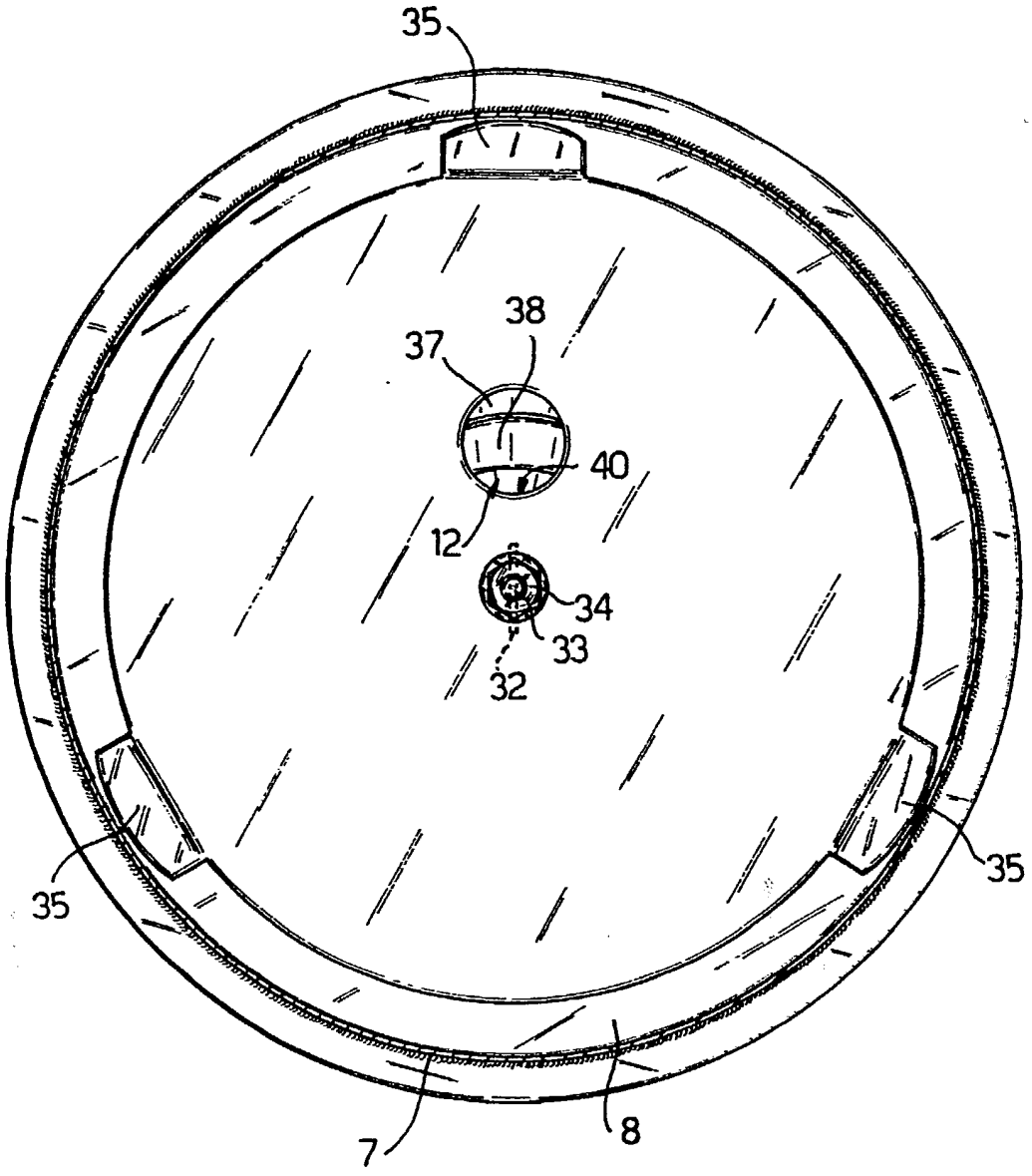

Fig. 2

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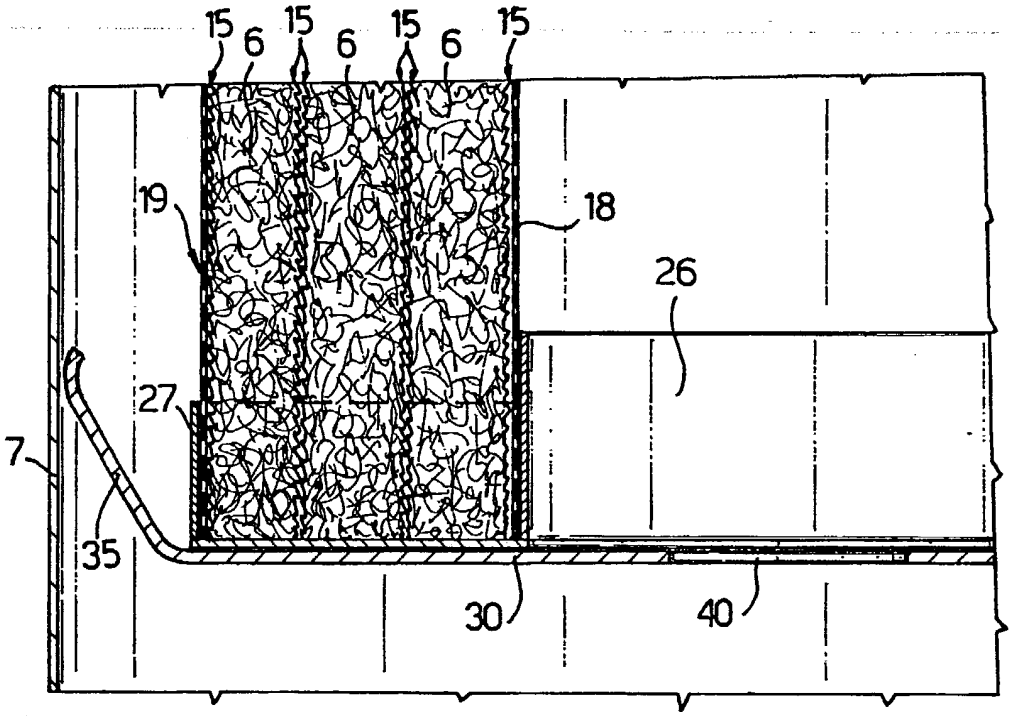


Fig.3

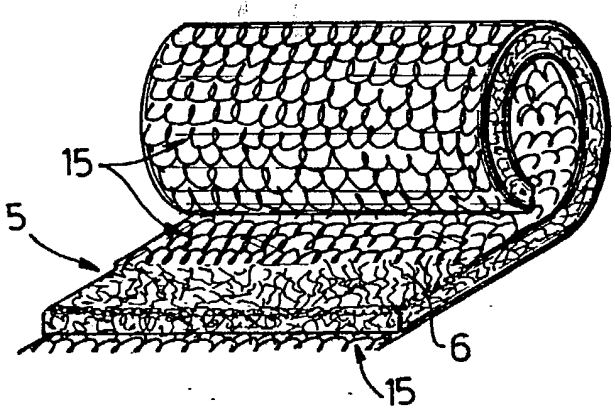
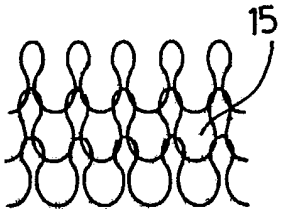


Fig.4

Fig.5



(Dr. Ing. Paolo JORIO)

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EUROPEAN SEARCH REPORT

Application Number

EP 89 10 8116

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	US-A-4175107 (IWAOKA)	1, 3-5,	F01N3/02
	* column 3, line 3 - line 40 *	22, 23	F01N3/28
A	* column 4, line 41 - line 49 *	6, 8, 9	
	* figures 3, 12 *	25	
X	US-A-4195063 (IWAOKA)	1, 3-5,	
	* column 2, line 11 - column 4, line 8 *	22	
A	* figures 1, 2, 6-8 *	6, 8, 9	
X	US-A-4220625 (TOH)	1-3, 5,	
	* column 2, line 52 - column 4, line 7 *	6	
A	* column 7, line 33 - line 62 *	4, 8, 9	
	* figure 10 *		
X	CH-A-447718 (BERLIET)	1, 2, 5,	
	* the whole document *	26	
A		4, 9, 10, 15	
A	CH-A-469900 (BERLIET)	1, 2, 4,	
	* the whole document *	9, 10, 15, 22, 23, 26	TECHNICAL FIELDS SEARCHED (Int. Cl.4)
			F01N
A	DE-A-3228325 (EBERSPÄCHER)	1, 2,	
	* page 7, last paragraph - page 8, last paragraph; figure 1 *	25, 26	
A	DE-A-3545762 (LEISTRITZ)	1, 6-8,	
	* the whole document *	26	
A	GB-A-832890 (BENDIX)		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	07 AUGUST 1989	FRIDEN C.M.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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